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Some Factors in Agricultural Cost Production.

I. D. Graham and T. D. Hammatt.

The earliest known record of the gathering of statistical information dates back to the year 3050 B. C., and the use and value of such knowledge has been growing since. It is only within the last half century, however, that the proper system of dealing with large numbers, or of numbers gathered from numerous sources, has really attained the dignity of science.

The value and application of this new science has been brought home to the people of this country in recent years with a force which has rendered it of very high economic importance. During the war period, when it became necessary to fix the price of wheat and other agricultural commodities, it was found that the necessary knowledge to do this was lacking. Although wheat is the oldest crop known to man, no one knew what the cost of production might be for any large area, and such knowledge was vital.

MODERN STATISTICS.

One of the most valuable characteristics of modern scientific statistics lies in the fact that it gives us a sufficiently accurate picture of a group of objects without going through the laborious and expensive process of a complete enumeration of all the items in the group. Thus it is by no means necessary in ascertaining average cost of producing an acre or bushel of wheat to obtain complete data in regard to each acre or every bushel.

If a considerable number of typical instances can be obtained and properly arranged, the difference from the true average value per acre or per bushel of all the acres or bushels in the state will be so small as to be, for all practical purposes, of no importance.

The anthropologist discovers the physical characteristics of a tribe or race by making careful measurements of only a small minority of the whole. If two persons were blindfolded and required to pick several hundred apples from a bin containing a million, the average weight of the selected groups of apples would equal each other, although the apples might vary considerably in size. Not only this, but the average weight of all of the selected apples would be the same as that of the larger number remaining in the bin.

This fact is based on a law of nature which is formulated in the mathematical theory of probabilities. Under this theory a moderately large number of items taken at random from among a very large group is practically sure, on the average, to have the characteristics of the larger group. This is the law upon which the whole system of life insurance is based, and while it is not claimed that these results are mathematically exact, it is emphatically stated that they are sufficiently accurate for all practical purposes, and are so used in large business enterprises generally as well as in the scientific work of such men as Luther Burbank.

TWO METHODS.

There are two methods of applying this law in the gathering and use of agricultural statistics. The first is called a "survey," and attempts a minute analysis by experts of a single farm or a small group of farms which are considered typical. Upon this method have been based the efforts made by governmental and other agencies to secure desired information upon the cost of production and other necessary facts regarding farm crops and management. Generally speaking, the results obtained under this method have been sufficiently accurate to give a fair idea of the approximate cost, but this method lacks in that it cannot show results which are typical of areas so large as a state or a region where information concerning the dominant crop is sought.

The second method is by means of the "questionnaire," through which every county in the state is covered and the assembled replies averaged in detail, so that an accurate picture of the customs, methods and costs of that state is shown. Through this method accuracy is secured by covering enough farms in all parts of the state to insure an average which shall be typical. Through it a wider field may be covered than by the survey, and there is a great saving of time. The expense of collecting information by this means is very much less, and such information has the merit of uncolored farm facts received at first hand.

Under the conditions engendered by the World War and the succeeding reconstruction period the wheat crop has assumed a previously unknown importance, and the Kansas State Board of Agriculture became the leader in an investigation of the methods and costs of production of this crop, which is the first real effort, with which we are familiar, of any large class of producers, manufacturers or distributors to show the exact cost of services rendered. Haphazard inquiries as to the cost of producing a farm crop have usually brought replies which vary widely and have given rise to the impression that the farmers do not know their business. By the use of the questionnaire method, Secretary J. C. Mohler, of the Kansas State Board of Agriculture, has not only determined that while many farmers will hesitate when asked to give accurately the cost per bushel or per acre of producing wheat or other crops, they do really know their business and can give accurate statements of fact as to the items which make up the cost of production.

It is very often true that the cost of production of an acre of wheat on one farm will greatly exceed that upon an adjoining farm, and every item in the cost account of each farm be accurate and within the limits of economic farm practice. It is also true that there will be a marked variation in the cost of wheat raised on the large acreage of the farmer who specializes in this crop and has the necessary equipment with which to handle it, when compared with that produced on a farm where wheat is only an element in a regular rotation of crops or where it is incidental to a necessary change of crops.

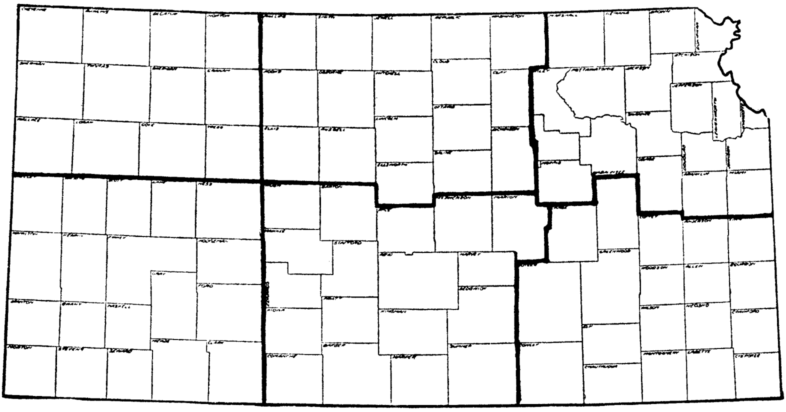
In sending out some 10,000 questionnaires to the wheat-growing farmers of Kansas, Secretary Mohler did not ask the farmers to give their answers in lump sums, as this would have resulted in a confusion of replies, due to the fact that very few of these farmers are in the habit of keeping accounts in such detail as to furnish the desired information.

THE FARMER HAS KNOWLEDGE.

The farmers do, however, have exact knowledge of the various items which should enter into such an average as was sought, and by adapting the method of questioning to the habits of thought of the farmers and the character of the information which it was known they could furnish, Secretary Mohler was able to acquire and have analyzed a vast amount of information, the sum total of which comprises exactly what was desired.

As an illustration it may be stated that in the analyses of the replies the state was divided into sections, as shown by the accompanying map, and the details worked out for each section, and then the whole was correlated for the state. This was done because it was found that for the purpose of this investigation the conditions and methods of production were so similar in every case that the section was the smallest unit necessary. The facts and figures obtained for any section are applicable to every county in that section.

It was also found that the variation in methods and the consequent cost occurred from east to west, according to the amount of rainfall, and that only slight variations occurred from north to south in the state, where the difference in rainfall is less apparent.



If throughout a given division conditions and methods of production are similar, the average cost of production in the northern and southern sections of the division must be similar, and if the averaged replies from several hundred farmers in each division are similar, strong evidence is afforded of the essential accuracy of their replies. The reports received from farmers coöperating in this investigation present such evidence. This may be shown clearly by a few examples:

	Seed wheat		*Machinery,*	*Horses*	
	Pecks per acre.	*Price per bu.*	*charge per acre.*	*Charge per year.*	*Days used per year.*
Eastern division:					
Section A	5.3	$2.24	$1.99	$162	165
Section B	5.2	2.19	1.83	153	173
Central division:					
Section C	4.6	2.24	1.72	130	155
Section D	4.2	2.23	1.83	131	153
Western division:					
Section E	3.3	2.14	1.21	121	154
Section F	3.1	2.21	1.25	132	156

	Preparing the seed bed, cost per acre.	*Harvesting, cost per bu.*	*Threshing, cost per bu.*
Eastern division:			
Section A	$3.74	27.1¢	31¢
Section B	4.08	26.3	32
Central division:			
Section C	2.80	29.5	30
Section D	2.75	27.0	31
Western division:			
Section E	2.00	22.7	30
Section F	2.27	23.0	28.6

The 2,040 wheat growers whose statements were used in compiling the cost data represent every county in the state and include both landowners and tenants, and small as well as large producers. Their aggregate experience in wheat growing in Kansas covers 31,792 years and the area of their farms is 491,062 acres. From these sources have been derived the necessary facts which have resulted in a determination of the cost of production of wheat in Kansas.

The average cost of producing an acre of wheat in Kansas for the crop of 1919, and the average return per acre from wheat sold to December 1, as reported by Kansas farmers, was as follows:

The state:		
Cost per acre	$25.20	
Return per acre	24.77	
Loss per acre		$0.43
Eastern division:		
Cost per acre	$33.75	
Return per acre	33.60	
Loss per acre		.15
Central division:		
Cost per acre	$24.60	
Return per acre	23.08	
Loss per acre		1.52
Western division:		
Cost per acre	$18.60	
Return per acre	20.46	
Gain per acre		1.89

These amounts show that there was a loss to the farmers of Kansas on the crop of 1919, but these amounts do not show the full extent of this loss, because it is impossible to express in exact figures and to include in the expense account certain factors, stated hereafter, by which the wheat grower is materially affected.

If the return from the crop had been exactly equal to the cost as computed in this investigation, the farmer would have received—

A moderate rate of interest (5 per cent) for the use of capital represented by land, buildings and equipment used for wheat.

The going wage of a farm hand for his labor, or for the greater part of the time devoted to wheat—$55 a month and board.

A compensation of $2.50 per day for his services as a manager for the time devoted to wheat, averaging 97 days.

Sufficient allowances to cover necessary repairs and replacements.

One-third his house rent.

Some protection against crop failures through charging to the acres harvested the cost of seed and seeding for acres abandoned annually.

But the return from the crop failed to afford such compensation as this by the amount already stated; and further, in calculating the cost of the crop in this investigation the farmer has been allowed—

Nothing for the loss of fertility of his soil.
Nothing for idle time due to the seasonal character of his vocation.
Nothing in the nature of "overtime" allowances for long working days during the busy season.

With the information at hand we cannot evaluate these three charges against the crop. But as wheat growing is carried on in Kansas, they are material factors in the cost of production.

ELEMENTS OF COST.

In order to show the elements entering into the computation necessary in determining the cost of production of wheat in Kansas, the accompanying statement showing the various charges per acre in the central division is immediately followed by statements showing the items of charge in each section of the central division. These latter have been correlated in order to produce the former:

CENTRAL DIVISION.

		Charge per acre.
1.	Land and buildings used for wheat $81.00 per acre @ 7% (interest, taxes, upkeep). 12.30 per acre @ 13% (interest, taxes, depreciation, repairs).	$7.27
2.	Use of machinery (interest, taxes, depreciation, repairs)	1.63
3.	Seed 4.40 pecks @ $2.23 per bu.	2.46
4.	Seed-bed preparation 4.40 man hours @ 25¢. 19.20 horse hours @ 8¾¢.	2.78
5.	Harvesting (binding and heading) 3.60 man hours @ 7.3¢. 5.20 horse hours @ 8¾¢. Twine and oil, 32¢.	3.41
6.	Threshing 12.00 bu. @ 30½¢. per bu.	3.66
7.	Hauling to market 5.20 miles @ 1.1¢. per bu. per mile.	.68
8.	Insurance (all classes)	.63
9.	Fertilizer	.79
10.	Interest on seed and seed bed	.40
11.	Crop risk	1.31
12.	Correction for rent	.14
13.	Management	1.43
	Gross cost	$26.59
14.	Credit by straw and pasture	1.55
	Net cost	$25.04
15.	Net cost adjusted to allow for differences in acreage in different sections	$24.60

CENTRAL DIVISION.

NORTHERN SECTION (C.)

		Charge per acre.
1.	Land and buildings used for wheat $78.40 per acre @ 7% (interest, taxes, upkeep). 13.50 per acre @ 13% (interest, taxes, depreciation, repairs).	$7.24
2.	Use of machinery (interest, taxes, depreciation, repairs)	1.72
3.	Seed 4.60 pecks @ $2.24 per bu.	2.58
4.	Seed-bed preparation 4.60 man hours @ 25¢. 19.30 horse hours @ 8½¢.	2.80
5.	Harvesting (binding and heading) 3.95 man hours @ 75¢. 5.50 horse hours @ 8½¢. Twine and oil, 41¢.	3.84
6.	Threshing 13.00 bu. @ 30¢. per bu.	3.90
7.	Hauling to market 5.50 miles @ 1.1¢. per bu. per mile.	.77
8.	Insurance (all classes)	.67
9.	Fertilizer	.98
10.	Interest on seed and seed bed	.42
11.	Crop risk	1.56
12.	Correction for rent	.42
13.	Management	1.61
	Gross cost	$28.51
14.	Credit by straw and pasture	1.56
	Net cost	$26.95

CENTRAL DIVISION.

SOUTHERN SECTION (D.)

		Charge per acre.
1.	Land and buildings used for wheat $82.89 per acre @ 7% (interest, taxes, upkeep). 11.61 per acre @ 13% (interest, taxes, depreciation, repairs).	$7.31
2.	Use of machinery (interest, taxes, depreciation, repairs)	1.54
3.	Seed 4.20 pecks @ $2.23 per bu.	2.34
4.	Seed-bed preparation 4.20 man hours @ 25¢. 19.00 horse hours @ 9¢.	2.75
5.	Harvesting (binding and heading) 3.31 man hours @ 70¢. 4.88 horse hours @ 9¢. Twine and oil, 23¢.	2.98
6.	Threshing 11.00 bu. @ 31¢. per bu.	3.41
7.	Hauling to market 5.00 miles @ 1.1¢. per bu. per mile.	.60
8.	Insurance (all classes)	.59
9.	Fertilizer	.60
10.	Interest on seed and seed bed	.39
11.	Crop risk	1.05
12.	Correction for rent	—.16
13.	Management	1.25
	Gross cost	$24.65
14.	Credit by straw and pasture	1.53
	Net cost	$23.12

The object in determining the cost of production per acre rather than per bushel is found in the fact that the variations in the cost per bushel are more directly affected by the yield, and the tables here given as showing the cost of production of the wheat crop in 1919 can be used for any other year by merely changing the items which go to make up the final cost to correspond with the facts at that time.

FACTORS OF COST.

In the use of machinery, horses and labor, only that portion of the value of labor which was devoted directly to the wheat crop is included in this report. In these values 51 per cent were given by those who own and operate their land and 49 per cent by those who operate rented land. A rate of 7 per cent was allowed for the use of land, and this includes 5 per cent for the use of the money invested, 1¼ per cent for taxes, ¾ per cent for upkeep charges, such as fences, road work, etc.

The rate of 13 per cent allowed for the use of buildings or parts of buildings which were used in handling the wheat crop includes 5 per cent for the use of the money invested, 4 per cent for depreciation, 2 per cent for repairs and maintenance, 1¼ per cent for taxes and ¼ per cent for insurance. The eastern division, as shown by the map, had 25.18 per cent of its cultivated area devoted to wheat, 69.2 per cent to other crops and pasture, and 4 per cent to waste or unused land. For the central division the figures are 43.8 per cent for wheat, 54.2 per cent for other crops, and 2 per cent for waste land; while for the western part 32 per cent was devoted to wheat, 67 per cent to other crops, and 1 per cent to waste land.

In the charges covering the use of machinery, implements, wagons and harness, only such value was given as was directly chargeable in the production of wheat. This included interest on the money invested, taxes, depreciation and maintenance and repairs, and was based on the value of the machinery and the length of useful life as reported by the correspondents.

The charge for seed includes the average cost of seed in each section, together with any expense incurred in transportation of the seed or its treatment for smut. In the labor of preparation of the seed bed and seeding the farmer was allowed a nominal charge of 25 cents per hour, which is equivalent to a hired man's wage of $55 per month and $20 per month for board. The charge for horse hours were based on interest on investment, depreciation, immediate care, shoeing, veterinary fees, and the report by each correspondent of the total number of days of horse labor used each year in the production of wheat, together with the cost per year of keeping a work horse.

Harvesting charges include the daily cost wage reported by the correspondent plus $1 a day for board and lodging. The figures reported under the head of harvest differ in different sections of the state, for the reason that harvesting is done in the eastern division almost exclusively by means of the binder, while in the western division the header is almost exclusively used, and in the central division both of these implements are used. The charge for threshing and for hauling to market were compiled directly from the replies given, though the hauling charge is based on the cost of hauling one bushel for one mile, the yield per acre and the distance hauled.

The charge for insurance covers whatever insurance was carried, though there are many farmers who do not carry insurance either on the growing crop or on stored grain. Also the charge for fertilizers is small, for the reason that many farmers do not make a practice of fertilizing for the wheat crop. It will be noted from these figures that the farmer has been allowed only the wages usually paid to a farm hand. No special pay has been credited to his account for his extra ability as a manager.

Owing to the fact that the coöperating farmers who furnished the information upon which these calculations were based may not represent the true proportion of landowners and renters which exists in the state as a whole, it was necessary to make a correction for rent. In Kansas the almost universal terms of rent are one-third of the crop, and by using the information furnished in the last government census report as the basis of calculation, such corrections were made as were necessary in each section. This may appear as an addition to the cost of production on owner-operated land because of the fact that the rent exceeds the charge for the use of the land and buildings which we have used in these calculations. This correction has in every case been a slight one, but was necessary in the interest of accuracy.

It may be further stated that the results shown herewith are under rather than above the actual facts in some instances. The farmer has been allowed no extra compensation for his ability as a manager, and this should have been done; the only allowance given him in the shape of wages being that equivalent to what he actually paid the hired help on his farm.

Another element of importance in such a computation is one which is frequently overlooked, and for lack of a better term has been named "crop risk." This term is intended to provide for compensation for the seeding and preparation of wheat land from which no grain is harvested. The variable seasons in a state so large as Kansas and having such a wide diversity of climatic and soil conditions result in the failure of the farmers in some parts of the state to harvest all of the land which has been sown to wheat, and this recurring loss must be provided against in any calculation which is intended to accurately show the cost of production. For example: If one acre in five sown to wheat is lost through climatic and other conditions, the four acres remaining must bear the cost of the seed, the seed-bed preparation and the sowing of the five acres, and this difference is taken account of under the term "crop risk." It is shown from the figures published by the Kansas State Board of Agriculture that the loss on the several divisions into which the state has been divided for the purpose of this investigation are as follows: Northwestern, 11 per cent; southeastern, 9 per cent; north central, 25 per cent; south central, 18 per cent; northwestern, 38 per cent; and southwestern, 45 per cent.

It is found that the average number of days devoted to wheat in the eastern division of the state was 80; in the central division, 106; and in the western division, 104; while the average wheat fields in eastern Kansas measure 65 acres; in central Kansas, 182 acres; and in western Kansas, 235 acres.

The purpose of this paper has been to give somewhat in detail the facts which are absolutely necessary in the determination of any reliable statistics concerning a farm crop, but incidentally the inquiry has been of great benefit in other ways as well. Many farmers have had their interest aroused and neighborhood discussions have been encouraged, a spirit of coöperation fostered, and the possibility of a knowledge of the cost of production in helping farmers toward a more economic method has been developed. The highest value of this work in the mind of the writer lies in the fact that it will serve to remove much misinformation which exists in the minds of the public in regard to the profits which are popularly credited to the farmer, and show that the wheat farmers of Kansas, at least, are not profiteers.

Another vitally important fact that has been developed by this investigation is to be found in the example which it has set for the obtaining in an accurate and reliable manner the essential facts of cost of production upon which all business enterprises should be based and which heretofore have been so universally lacking when applied to agriculture, which is our greatest and most fundamental business.

Standards of Purity for Medicinal Agents.

L. E. SAYRE.

The tenth revision of the United States Pharmacopœia will soon be started. The convention which will appoint the members of the next revision committee meets in Washington on May 11. About fifty revisers will be chosen at that time. It is therefore quite important at this time to call the attention of chemists to the standards that are embraced within the pages of the present revision of the Pharmacopœia. Almost every chemist who has anything to do with laboratory work or investigation and research is interested in this question of standards, and therefore it is advisable that everyone who has anything to do with chemistry shall feel free to contribute to the standards for medicinal chemicals.

It is well known that the United States Pharmacopœia does not require absolute purity with regard to chemicals. Absolute purity in many of the com-